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Graduate Management Project:

The Impact of Pharmaceutical Expenses and the use of Flexible Budgets at The Johns Hopkins Hospital

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Abstract

Pharmaceutical expenses are dramatically increasing and must be adequately forecasted, planned, and controlled. Hospitals must invest in analytical methods that identify changing patterns in drug utilization and that identify those units that utilize appropriate resources as models of healthcare delivery. A flexible budget model for pharmaceutical expenses and the underlying cost analysis represents one such opportunity for hospitals to adequately manage pharmaceutical budgets.

The purpose of this study was to evaluate the pharmaceutical costs, Length of Stay (LOS), and the All Patient Refined-Diagnostic Related Group Severity Index (APRSI) for the Functional Units at the Johns Hopkins Hospital (JHH) for the development of a justifiable flexible budget model for the pharmaceutical budget. This was accomplished by applying traditional multivariate techniques to perform a quantitative analysis of the hospital pharmaceutical costs. Specifically, four areas were examined: LOS, APRSI, pharmaceutical costs by Functional Unit, and by Major Diagnostic Group. The results of these techniques and the implications for further use in a flexible budget model at JHH are discussed. The research showed that although LOS and APRSI provided a statistically significant explanation of

variance in pharmaceutical costs, the correlation was not sufficient to justify using these measures in a flexible budget model.

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Introduction

Cost containment initiatives, such as the Prospective Payment System, are forcing hospitals nationwide to compete more intensely with other hospitals based on cost and quality. This problem is particularly evident today as hospitals and health plans struggle to keep skyrocketing drug costs and spending under control. The extraordinary pace of new drug development, unprecedented promotion of drug products to care providers and patients, and a vast change in drug pricing are fueling this explosion of increased costs (Hensley, 1999). If pharmaceutical expenses cannot be adequately forecasted, planned, and controlled, the quality of patient care will suffer as resources continue to dwindle and cost cutting efforts are forced to take place elsewhere in the system to make up for dramatic cost increases. Hospitals must invest in analytical methods that identify changing patterns in drug utilization and in methods that identify those units that utilize appropriate resources as models of healthcare delivery.

Problem Statement

As pharmaceutical expenditures become harder to accurately forecast and hospitals strive to control these expenditures in a timely manner, opportunities exist to benefit from tying the functions of financial analysis and

utilization management together. One such opportunity is further developing the flexible budget methodology for pharmaceutical expenses. Johns Hopkins Hospital (JHH) endeavors to develop realistic drug expenditure budgets that meet quality patient care requirements. In order to improve the funding of the pharmacy expense budget, key support for flexing this portion of the budget must be garnered from the Vice President of Finance. A key to this success is providing a more sophisticated flexible budget methodology at JHH.

Conditions Which Prompted the Study

Hospitals and healthcare organizations everywhere are struggling to keep up with the rise in pharmaceutical expenditures. Spending on prescription drugs is rising at a 12% annual rate, which is more than double the 5.1% rate increase in national healthcare expenditures. Appendix A shows the explosive growth in healthcare, hospitals, and prescription expenditures, respectively, that have taken place since 1980. Pharmaceutical costs currently claim nearly 8% of the national healthcare expenditures. According to the Health Care Financing Administration (HCFA), pharmaceutical costs are expected to increase annually at a 10% rate through 2007 (Hensley, 1999). Expenditures on prescriptions alone are expected to increase to more than 12 cents of every personal healthcare dollar spent in 2007 and to almost 13 cents of

every dollar in 2008 (Musco, 1999). The driving factors behind this growth are many. The aging population, the accelerated approval of new drugs by the Food and Drug Administration (FDA), direct-to-consumer advertising by pharmaceutical manufacturers, and cost advantages over alternate forms of care, most notably inpatient hospital care, are all contributing factors (Hensley, 1999; Musco, 1999).

Nowhere else are these factors felt more heavily than at an urban, teaching facility such as JHH. Heyssel, Gaintner, Kues, Jones, & Lipstein, (1984) reported that before 1972 at JHH, more than 80% of the hospital's costs were controlled centrally by administration. In 1973, JHH went about decentralizing management and budgets. By 1983, the cost allocation pattern was dramatically altered with clinical departments controlling 51% of their expenses. Another 20% were controlled by ancillary services, including pharmaceutical expenses. In 1998, responsibility for the pharmaceutical expenditure budget at JHH was transferred from the Vice President of Corporate Services to the Vice President of Administration. Appendix B shows the growth of pharmaceutical expenditures at JHH since fiscal year 1997 (FY97) and the amounts that the pharmaceutical expenditure budget was over budget for FY97 through FY99.[1]

[1] The fiscal year at JHH runs from the beginning of July to the end of June the following calendar year.

In the past, Finance and Pharmacy have been unable to accurately identify the variances and forecast the amounts to expect in the pharmaceutical expense budget. In an era of finite resources and limited capacity, Pharmacy is under close scrutiny to prove the need for additional funding in the pharmaceutical budget.

Literature Review

An extensive literature search yielded pertinent information as to how the utilization of pharmaceuticals in the current healthcare environment is affecting JHH budgeting efforts. Additionally, information on how healthcare entities are dealing with the current climate in the pharmaceutical industry and the impact of pharmaceutical inflation in their budget forecasts, as well as many specific articles on information regarding the methods by which hospitals project drug expenditures were reviewed. There was an extensive focus in much of the literature by a rather small number of authors with respect to flexible budgeting within the hospital industry and within the industrial sector of the economy which tied flexible budgeting and healthcare delivery together. The literature review was conducted by researching JHH internal policies and procedures, methods reported by healthcare and industrial business texts and journals on flexible budget methodology as well as cost accounting methods utilized to

track, measure, capture, and assess costs. Additionally, literature was reviewed as to whether length of stay (LOS), severity index, or case mix index (CMI), either independently or in combination, provided the basis for “flexing” a budget to actual experience. This literature review allows an accurate assessment of the budgetary environment for pharmaceutical expenditures within the healthcare market.

JHH Policy & Procedure

Per the JHH Department of Finance Budget Guidelines Update, FY00 Budget (1999), during the planning phase, each department was required to prepare and present a Departmental Situational Analysis. Functional Unit’s (FU) at JHH, which are equivalent to departments in most hospitals, were to utilize the Volume Estimating Reports by Physician for Discharge, LOS, and Inpatient Days, distributed by the Planning and Marketing Department as a basis for volume estimating. Also made available were the current FY Casemix Adjusted LOS by Diagnostic Related Groups (DRG) Reports. LOS was reviewed and approved on a unit-by-unit basis and each FU was expected to implement measures to meet the LOS performance targets. FU’s then formulated projections for FY00 inpatient and outpatient volumes. Ancillary departments were expected to develop their budgets in conjunction with inpatient and outpatient units. According to the JHH Department of Pharmacy

FY00 Budget Submission (1999), a proposed Pharmacy budget of $51,042,143 was submitted that included a 15.9% inflation adjusted request for pharmaceutical drugs & supplies of $39,360,027. The 15.9% rate of inflation was based on the growth rate from actual drug expense between January year-to-date (YTD) 1998 and Jan YTD 1999.

Projecting Pharmaceutical Expense

The major changes in healthcare today require those who project budgets to have much more information than they have had in the past. Mehl and Santell (1997, 1998, & 1999) discuss projecting future drug expenditures. These articles take a look back at factors affecting the price and usage of pharmaceuticals as well as a look ahead to the new year and how these major changes will affect pharmacy practice and drug expenditures. The difficulty and complexity of projecting pharmaceutical costs are made clear. Mehl and Santell's (1999) work reflects the same findings of Hensley (1999) and Musco (1999), i.e., that the pharmaceutical industry has entered an era of accelerating growth driven by new product approvals, major therapeutic breakthroughs, and demand for new agents by a better educated public.

Mehl and Santell (1998) point out that the use of historical indices in projecting pharmaceutical budgets is limited. A healthcare organization must have trends by which

to compare themselves, but they must also be able to understand the deficiencies that exist in the use of such indices. Most major indices, such as the Producer Price Index (PPI), and Maryland's Health Services Cost Review Commission (HSCRC) indices, are based on price or cost, and some are sales weighted, but they do not generally take new drugs into account or whether changes in drug therapy or utilization has taken place.

The Prescription Drug User Fee Act of 1992 and the FDA Modernization Act of 1997, which renewed the 1992 Act, reduced review time for investigational drugs and drugs to treat life-threatening illness, including cancer and AIDS, and increased the speed at which the FDA approved new drugs. This continues to be the case. The ability to predict when new molecular entities (NME) will be introduced, their cost, and their level of use is essential in projecting pharmaceutical expenditures. Many methods of projecting the financial impact of changes in drug therapy can be used. But Mehl and Santell (1997) point out that detailed, specific information is essential on each drug. The anticipated date of availability of any NME and its indication(s) for use is required. Current therapy versus new therapy and whether increased utilization, i.e., the number of patients to be treated (monthly and yearly) and the cost per treatment must be calculated. Additional supplies, and labor

costs or savings must be taken into account. It is the pharmacist's responsibility in preparing the pharmaceutical budget to be familiar with changes in therapeutic knowledge that may directly affect cost projections. The financial viability of the healthcare organization must be taken into account in projecting expenditures, i.e., does the new therapy reduce the overall patient care costs, what is the total cost for the budgetary period, and what are the effects on other organizational budgets. The final decision on inclusion of these new drugs cannot be based solely on the economics of the medications, but rather must also take into account their efficacy.

The strength of research and development (R&D) pipelines continues to fuel this fast pace of approval also. Myshko's studies (1997, 1998) reviewed the new product pipelines of the top 50 pharmaceutical companies in 1996 and 1997. Those identified as having the strongest drug pipelines had all made extensive investments in R&D in 1996 and 1997 and expected to have a substantive amount of NME's on the market in 1999 which are considered "blockbuster" drugs, i.e., those with sales exceeding $500 million per year. The pharmaceutical industry could double the current $265 billion global market within five years with the introduction of super blockbuster drugs with sales of $1 billion to $3 billion per year. The

increased speed at which these newly approved drugs are hitting the market and the strength at which R&D pipelines are feeding this engine, along with other major changes in the healthcare industry, only makes the budgetary process for pharmaceuticals more challenging.

As the pharmaceutical industry continues to change, the budgetary process must also. Mehl and Santell (1997) state that even though basic concepts of forecasting and evaluating are still required, the thought process must change. Past consideration was given to inflation, historical data, prior year expense, CMI, LOS, admissions, and NME's. Although efforts at JHH have been made to move beyond this method of forecasting, future consideration must be given at JHH to further integration of drug expenditures in the organization's objectives, the ability of drug budget increases to be offset by reductions in other service costs, effects on rate regulation and competition, relocation of services from the inpatient arena to the outpatient, and shifting control and responsibility for the drug budget to the patient care centers.

Flexible Budgeting

During the execution phase of the budget process, JHH utilizes a volume flexing budget methodology, which makes adjustments to budgets on a volume basis. According to the

JHHS Policy & Procedure FIN085 (1997), operating expense performance is measured monthly on a departmental basis relative to fixed departmental budgets. This measurement is reported and variable budgets are developed based on deviations in patient volumes upon which fixed budgets were based. This is used to explain expense variances in conjunction with the revenue variance report. It is also used to measure the efficiency of departmental resource utilization. Written explanations of expense variances of greater than plus or minus five percent of budget at the expense category level are required. These variance reports are required even in absence of an aggregate departmental variance. They are then utilized to validate monthly financial statements before they are published. Strict reporting timelines are to be followed. When an unfavorable expense variance is experienced for a consecutive two-month period, a written action plan outlining specific corrective steps to be taken must be submitted to senior management.

Volume, Quantity, & Price.

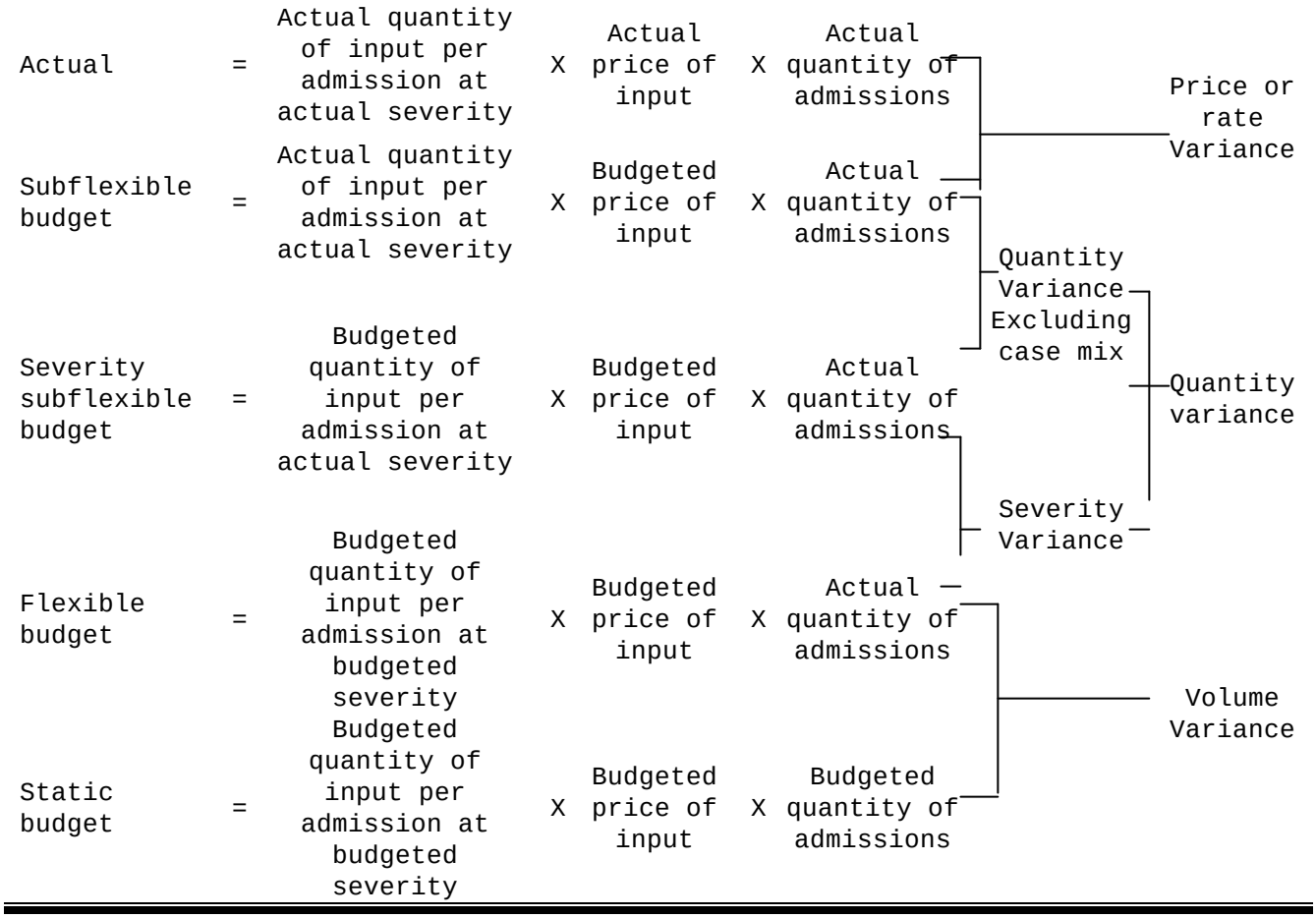
According to Finkler (1994), this level of flexible budgeting that simply breaks out the portion of each line-item variance caused by changes in volume alone and the remaining portion caused by other factors still does not bring JHH to a

sophisticated enough level of variance analysis utilized by most industries. Flexible budget variance analysis not only calls for analysis on volume or quantity of service, but also on price or rate, i.e., that portion of variance due to changes in the price or rate of the unit input. Additionally, variance may be broken down further by three main causes, more or fewer units of activity, than expected, a higher or lower price or rate paid for resources consumed, and more or fewer resources consumed per unit of activity.

Volume variance is the difference between the expected budgeted volume (the static budget) and the actual volume achieved (the flexible budget). This is what JHH traditionally breaks out for the clinical units. The unexplained variance remaining may include two additional causes of variance. One, which is explained by comparing actual costs with the actual quantities at the budgeted price, is the price variance. The other variance is explained by comparing the actual quantities at the budgeted price with the flexible budget, giving the quantity or use variance (Finkler, 1994). Figure 1 demonstrates the relationships between the different variances described.

Figure 1

FLEXIBLE BUDGET VARIANCE FOR VOLUME, PRICE, QUANTITY, AND SEVERITY



Adapted from S. Finkler, Health Care Management Review (1985), Flexible Budget Variance, Generic Formulation for Acuity and DRGs

One of the benefits of expanding this variance analysis is that it allows for isolation of problem areas. Focus on large variances may result in more efficient use of time and effort on the part of responsible parties. By setting a cutoff limit at which you will investigate a variance, small variances with little or no significance can be sorted out quickly. As previously discussed, JHH does this by only requiring an explanation for those variances greater than plus or minus 5%. At times a negative variance due to price may

offset a positive variance due to volume or vice versa and no difference will be detected if for the more complete variance analysis which splits out both. The cost of gathering this information cannot be ignored. As pointed out by Finkler (1991), the organization's accounting system should contain this required information. How easily this information can be retrieved, the volume which must be collected, and the tradeoff between the advantage of retrieving this information and the cost to obtain it may not be economically feasible.

Severity.

Finkler (1994) describes the use of an acuity or severity of illness variance which denotes the actual amount of spending versus that, which was budgeted due to severity of patient illness, different from what was expected. Since quantity variance represents all factors that end in consumption of more input per unit of output than budgeted, the variance due to severity of illness, or acuity, is contained within this quantity variance. The author states that healthcare organizations that have functioning patient classification systems can translate patient acuity levels into required hours of patient care. The flexible budget provides for budgeted quantities of resource inputs at the expected acuity level. By basing the budgeted resources on the actual volume of output, the budget is flexed on volume.

The actual quantities at the budgeted price represents both the actual quantities and the actual acuity level. The budgeted inputs for actual acuity maintains the use of budgeted prices as does actual quantities at budgeted price, but it also maintains the use of the actual output volume as does the flexible budget. It differs by the use of the quantity of input that would have been budgeted per unit, had the actual acuity been known. Since the flexible budget provides for the actual amount of output, the budgeted inputs for actual acuity category provides the budget for the actual amount of output that are used at the actual acuity level. The difference between this and the flexible budget is called the acuity variance (budgeted acuity versus actual acuity). The difference between this category and the actual quantities at a budgeted price category is designated as the quantity of inputs consumed that is distinct from that. This is expected for the actual volume of output at the actual acuity level.

Case Mix.

Shafer, Frauenthal, and Tower (1987) explain that the cost of care for each patient depends on two factors; the number of days of care received by the patient and the amount of care received each day. A patient day approach adequately accounts for the first factor, but it takes the patient case mix factor to account for both the LOS and the intensity of

care. The four steps listed by Kerschner and Rooney (1987) for developing a case mix budget are (a) budget the number of cases by DRG, (b) develop resource utilization profiles for each department, (c) apply budgeted cases to the profiles, and (d) calculate the department budgets. If numbers are daunting due to the large number of DRGs, they recommend streamlining methods, such as the 80/20 rule to begin concentrating efforts on the high cost DRGs or focusing on budgeting cases by Major Diagnostic Group (MDG) or by other DRG groupings. Kerschner and Rooney (1987) go on to state that by focusing on aggregate patient days and admissions, flexible budgeting ignores changes in the types of cases treated. They point out that a more accurate method of budgeting could be achieved if it accounted for changes in case mix. Finkler (1985) extends his flexible budget methodology by identifying case mix variance as a separate variance from that of acuity. This subportion of the quantity variance differentiates the overall variance caused by actual versus expected case mix. This equates to the budgeted quantity of input per admission for the actual case mix versus the budgeted quantity of input per admission for the budgeted case mix multiplied by the budgeted price of inputs and actual number of admissions. Admissions is used as the standard unit of measurement, as Finkler points out, since with prospective payment, focus shifts from LOS to each

admission. As LOS decreases, the amount of resources consumed per patient day must be controlled. Still, the author points out, concern must focus on resource consumption per admission by case mix type. Figure 2 summarizes the mathematical relationships of all the variances described.

Figure 2

FLEXIBLE BUDGET MATHEMATICAL RELATIONSHIPS FOR VARIANCE OF VOLUME, PRICE, QUANTITY, SEVERITY, AND CASE MIX

Volume Variance aQo x bPi x bQi - bQo x bPi x bQi	**Where:** **aQo:** The actual quantity of output **bPi:** The budgeted price of input per unit of input **bQi:** The budgeted quantity of input per unit of output **bQo:** The budgeted quantity of output **aPi:** The actual price of input per unit of input **aQi:** The actual quantity of input per unit of output **bQiaS:** The budgeted quantity of input per unit of output, at the actual severity level **bQibS:** The budgeted quantity of input per unit of output, at the budgeted severity level **bQiaC:** The budgeted quantity of input per unit of output, at the actual case
Price Variance aQo x aPi x aQi - aQo x bPi x aQi	
Quantity Variance aQo x bPi x aQi - aQo x bPi x bQi	
Severity Variance aQo x bPi x bQiaS - aQo x bPi x bQibS	
Case Mix Variance	

aQo x bPi x bQiaC	mix level
- aQo x bPi x bQibC	**bQibC:** The budgeted quantity of input per unit of output, at the budgeted case mix level

Adapted from S. Finkler, Essentials of Cost Accounting for Health Care Organizations (1994), Flexible Budgeting and Variance Analysis, Formulas for Price, Quantity, Acuity, and Volume Variances

All Patient Refined-DRG

An alternative put forth but rejected by Finkler (1985) is to replace the acuity variance with a case mix variance. A major criticism back in 1985 was that DRGs lacked the recognition of different levels of severity of illness within any given DRG. As the healthcare industry has evolved there has been increased demand for a patient classification system that can be used for applications beyond resource use, cost, and payment. A patient classification system was needed for the comparison of hospitals across a wide range of resource and outcome measures. These comparisons are used for such things as the evaluation of differences in inpatient mortality rates; the implementation and support of critical pathways; the identification of continuous quality improvement projects; the basis of internal management and planning systems; and, the management of capitated payment arrangements. In order to meet these needs, the objective of the DRG needed to be expanded in scope to address patient severity of illness and

risk of mortality as well as resource intensity (3M Health Information Systems, 1995).

The All Patient Refined-DRGs (APR-DRG) expands the basic DRG structure by adding four subclasses to each DRG. The addition of the four subclasses address patient differences relating to severity of illness (APRSI) and risk of mortality. APRSI and risk of mortality relate to distinct patient attributes. APRSI relates to the extent of physiologic decompensation or organ system loss of function experienced by the patient while risk of mortality relates to the likelihood of dying. Since severity of illness and risk of mortality are distinct patient attributes, separate subclasses are assigned to a patient for severity of illness and risk of mortality. In the APR-DRG system a patient is assigned three distinct descriptors, the base APR-DRG, the APRSI subclass, and the risk of mortality subclass. The four APRSI subclasses and the four risk of mortality subclasses are numbered sequentially from 1 to 4 indicating respectively, minor, moderate, major or extreme severity of illness or risk of mortality. For applications such as evaluating resource use or establishing patient care guidelines, the APR-DRGs are used in conjunction with severity of illness subclass. For evaluating patient mortality the APR-DRGs are used in conjunction with the risk of mortality subclass (3M Health Information Systems, 1995).

The JHH Department of Finance HSCRC APR-DRG Discussion (1998) brief presented data and information on the use of APR-DRGs to the HSCRC in an attempt by JHH to be able to use the APR-DRG methodology for pediatric case screening before the HSCRC for rate review purposes. It made a point that severity adjusted case mix data using APRSI provided valuable information for planning and management of operations. The improved understanding of severity of "product lines" and adjustment of nursing unit staffing to severity levels were two of the reasons stated as the purpose of the request. Additionally, it provided a database upon which to influence physician behavior, help determined benchmark standards to adjust for case mix shifts, and aided in negotiating managed care contracts on a severity basis.

Product Line Microlevel Analysis

Suver et al. (1992) states that there is no universal agreement on what the output of a healthcare provider should be. Instead of focusing at the test, procedure, or unit dose level approach as the final output, one might consider these as subactivity measures which can be costed in order to determine the cost of the organization's output. Therefore, a healthcare entity's product line can be measured by one of three ways, per diem, case per discharge, or case diagnosis. Finkler (1994b) states that product costing should focus on

assigning costs that the organization incurs to each patient that causes the costs to be incurred and that the best costing would be total specification of resources consumed by each patient, if the collection of such data were free. Barring this, highly accurate costing should at least be by product line, e.g., by DRG or APR-DRG. Messmer (1984) states that from a standpoint of cost control, each of the DRG classifications can be viewed as products to which standard cost concepts can be applied. Although Suver et al. discusses the advantages and disadvantages of using DRGs as a basis of output, APR-DRGs can be substituted to match the required criteria and, as pointed out above, overcome some of the weaknesses in using DRGs for such a purpose. At the APR-DRG case diagnosis level, an average by diagnosis can measure services provided; FU profit can be used as a profitability determinate; FU expenses can be used for cost control and monitoring; resource use by diagnosis can be monitored; a competitive comparison by specific diagnosis can be established; and micro-potential exists for budget forecasting. It is this micro-potential that will allow the pharmaceutical expenditure budget to start a zero-based review. The author points out that standards based on macromeasures are inadequate to sufficiently identify price and quantity variances or intensity of service, nor do they

allow managers the opportunity to effectively assess the causes of variances. Rather, calculation of standard costs requires the use of weighted or micromeasures of output. This is required to run a reliable management control program.

Unit of Activity.

JHH flexes most inpatient expense budgets on inpatient beddays or LOS. As discussed earlier, the importance of the measurement used in setting standards cannot be overemphasized. To correctly flex a budget, the unit of activity used should proxy for the expense incurred. A proxy measure must not only be simple and reproducible; it must also be applicable to, and collected on each unit to be analyzed. Given the literature findings and the readily available use of APR-DRGs at JHH, APR-DRGs can serve as a product unit and the APRSI should act as a proxy for severity of illness or acuity in a flexible budget methodology. Stevens, Hubert, and Edbrooke (1998) analyzed the potential for individual factors to act as an accurate proxy for the costs of care in an Intensive Care Unit (ICU). Two of those factors were LOS and case mix, using the United Kingdom severity of illness index for the UK Healthcare Resource Groups. They reported that although significant correlation between the costs of care and severity of illness, workload and LOS were found, these failed to predict the costs of care with sufficient accuracy to be

used in isolation. Based on their findings, it appears that case mix descriptors for the ICU that would allow costs to be predicted cannot be defined in terms of single factors. Hirth, Held, Orzol, and Dor (1999) evaluated the effects of case mix, practice patterns, features of the payment system, and facility characteristics on the cost of dialysis. The case mix analysis used a Case Mix Adequacy Special Study that collected information on dialysis patients' comorbid conditions as a proxy for case mix. They found that the relationship between case mix and costs was generally weak. They did however find that dialysis practice, i.e., treatment duration and other factors, did have a significant effect on costs. Using an alternative severity of illness index which took into effect a reevaluation of the patients severity during the patient stay, Horn et al. (1991) were able to increase the predictability of the case mix to LOS using LOS as a proxy for costs. Iezzoni et al. (1991) using a similar methodology, while examining six conditions, found admission and mid-stay severity scores generally were associated with higher charges. However, in the same study very little of the superior predictive power of the mid-stay score could be attributed to its serving as a proxy for LOS. These studies present a mixed result on the predictability of such factors as workload and case mix for predicting costs or its proxies.

An analysis of the predictability of LOS and case mix for pharmaceutical costs at JHH should therefore be performed before these factors can reliably be used in a flexible budget methodology.

Purpose Statement

The purpose of this study is to evaluate the pharmaceutical costs, LOS, and APRSI for the FU's at JHH for the development of a justifiable flexible budget model for the hospital pharmaceutical expense budget. The goal of this study is to identify units of analysis for flexing the pharmaceutical expense budget and to develop a flexible budget model that will better analyze the pharmaceutical expense portion of the centralized pharmacy budget.

Methods and Procedures

Unit of Analysis

This project focused on a quantitative analysis of available information. Specifically, this project reports the results of an application of traditional multivariate approaches. The relationship of LOS and APRSI to pharmaceutical costs was evaluated using methods similar to those utilized by Horn et al. (1991), Iezzoni et al. (1991), Stevens et al. (1998), and Hirth et al. (1999) in analyzing causal relationships in their studies. The results of these multivariate techniques and the implications of these results

for further use in a flexible budget model at JHH are discussed.

Data Collection and Source

Study cases were collected for the months of June to September of 1999 for all FU's at JHH by APR-DRG and by MDG. The time period was chosen to obtain recent data from the BDM pharmacy database system that only became available for all FU's at the end of June 1999. This timeframe included the HSCRC implementation of interim rate regulation during its current review.

The data source included the DataMart abstract database as well as the BDM pharmacy database system. The primary focus of the DataMart, which contains hospital inpatient and outpatient diagnostic data, LOS, charges, and payments similar to the Medicare abstract data, is to support resource data-analysis requirements of JHH and affiliated subsidiaries. The primary purpose of the BDM system is to provide pharmaceutical support in resource data-analysis down to the patient level and inventory management. Pharmaceutical cost information from the BDM system was merged with information on the APR-DRG tracked in the DataMart.

Ethical Considerations

Both databases have a unique patient identifier (PATCOMM) that ties the database information together. To avoid any

ethical concerns, the PATCOMM is not disclosed, as analysis was done at the APR-DRG and MDG level.

Data Analysis

The merged data was analyzed using SPSS version 7.5 and Microsoft ® Excel 97 software. Each inpatient disposition was treated as a separate observation or case, consistent with other studies that have involved data for multiple time periods (Brooke, Hudak, & Finstuen, 1994; Farley, D. & Hogan, C., 1990). To control for time-related changes in the data, a binary-coded variable was included to reflect the month to which each case referred (Brooke et al.). To control for FU-related and MDG-related changes in the data, binary-coded variables were included to reflect the FU and MDG respectively to which each case referred (Brooke, et al, 1994). The data yielded a sample size of 12,865 inpatient dispositions. This comprised the total population of all FU cases seen over the four month period at JHH. No trimming was done to the data in this study.

Operationalization of Variables

This project involved the specification and estimation via multiple regression of a general model of hospital drug costs for inpatient services. The operational definition of each variable is summarized in Appendix C. The regression

equation used to estimate the inpatient pharmaceutical costs can be written as:

$$Y_1 = a0U + b_1LOS + b_2APRSI + b_3Mth_1 + b_4Mth_2 + b_5Mth_3 + b_6FU_1 + b_7FU_2 + b_8FU_3 + b_9FU_4 + b_{10}FU_5 + b_{11}FU_6 + b_{12}FU_7 + b_{13}FU_8 + b_{14}FU_9 + b_{15}MDG_1 + b_{16}MDG_2 + b_{17}MDG_3 + b_{18}MDG_4 + b_{19}MDG_5 + b_{20}MDG_6 + b_{21}MDG_7 + b_{22}MDG_8 + b_{23}MDG_9 + b_{24}MDG_{10} + b_{25}MDG_{11} + b_{26}MDG_{12} + b_{27}MDG_{13} + b_{28}MDG_{14} + b_{29}MDG_{15} + b_{30}MDG_{16} + b_{31}MDG_{17} + b_{32}MDG_{18} + b_{33}MDG_{19} + b_{34}MDG_{20} + b_{35}MDG_{21} + b_{36}MDG_{22} + b_{37}MDG_{23} + b_{38}MDG_{24}$$

where Y_1 is the dependent variable of total drug costs per inpatient disposition for the multivariate regression model ran. Total drug costs for each inpatient stay included the total costs of all inpatient drugs administered during that stay. Independent variables in the model reflect the categories of operational efficiency, severity of illness, month, Functional Unit, and Major Diagnostic Group. Operational efficiency and severity of illness were chosen as independent variables based on similar methods utilized by Horn et al. (1991), Iezzoni et al. (1991), Stevens et al. (1998), and Hirth et al. (1999) in analyzing causal relationships in their studies. Operational efficiency was

measured by LOS which represents the length of stay for the assigned APR-DRG, and APRSI represents the All Patient Refined Severity Index for the APR-DRG. As discussed earlier, a binary-coded (1,0) variable representing month (Mth) was used to control for possible cross-month effects on drug costs. The FU and MDG variation in drug costs was operationalized respectively by a categorical measure of FU within the hospital and MDG assigned each hospital disposition.

Analytic Methods

Techniques of hierarchical multiple regression were used to test hypotheses that each independent variable specified in the model made a unique contribution to explaining variance in inpatient drug costs, over and above the variance it shares with other independent variables in the model (Brooke et al., 1994). The hierarchical analysis involved comparison of a series of reduced and full regression models that estimated the increase in $\underline{R^2}$ that resulted when each independent variable was added to a regression equation containing all other independent variables. The increment in $\underline{R^2}$ was interpreted as an unambiguous estimate of the variance in the dependent variable "uniquely attributable" to each predictor, net of all other variables in the model (Brooke et al.).

Results & Discussion

Descriptive Statistics

Descriptive statistics that summarize LOS and APRSI by FU, and pharmaceutical expenditure characteristics by FU and MDG are provided in Appendix D. These statistics reveal a large standard error in proportion to the cost means across the FU's and MDG's. This is to be expected based on the differences in services rendered under each individual FU and each individual MDG.

Expenditures & Severity of Illness.

For the period under study, overall severity of illness had a mean of 2.1 with a SE of 0.9. Severity of illness (APRSI) was greatest for Physical Medicine & Rehabilitation at 2.8, Oncology at 2.5, and Psychiatry at 2.1, and lowest for Anesthesia & Critical Care, and Ophthalmology, 1.8 and 1.6 respectively. The distribution of APRSI was highly centralized across FU's, an SE of 0.6 on the low side under Anesthesia & Critical Care, and four out of the remaining nine FU's having a SE of 0.9.

Expenditures & Length of Stay.

For the period under study, ALOS was 6.1 days with a SE of 8.0 days. ALOS was greatest for Psychiatry at 11.8 days, Physical Medicine & Rehabilitation at 9.7 days, and Oncology at 9.7 days, and lowest for Anesthesia & Critical Care, and

Ophthalmology, 1.2 and 2.0 days respectively. The distribution of beddays is very skewed amongst the hospital, with a substantial number (particularly in Anesthesia & Critical Care and Ophthalmology) having a very low number of beddays while others had very high LOS (particularly in Psychiatry, Oncology, and Surgery).

The last two columns of Table D1 describe the ALOS for those in the top 10% of the expenditure distribution. The ALOS for six out of the ten FU's in this top decile exceeded those for all of the individual FU cases by a factor ranging from 2.3 to 3.6. The patients in Oncology, Psychiatry, and Surgery in the top decile stayed an average of 28.1, 28.0, and 20.1 days respectively, compared to 1.3 days for the lowest ALOS in Anesthesia & Critical Care up to 17.6 days for Medicine. The LOS for persons in this top decile accounted for between 12.5% and 36.1% of total beddays in each individual FU.

Expenditures by Functional Unit.

For the period under study, over 85% of pharmaceutical expenditures were for drugs utilized in four of the ten inpatient FU's, Surgery at 26.7%, Oncology at 22.1%, Medicine at 20.7%, and Pediatrics at 15.5%. Of these FU's, Oncology's utilization is highly visible. Although Oncology ranks as fourth lowest in number of cases represented, it ranks second

highest in dollars expended for pharmaceuticals. Pediatrics, Surgery, and Medicine all rank approximately equal in percentage of cases versus percentage of dollars expended. Gynecology/Obstetrics appears to be the most economical. While it makes up 5.4% of the case population, it only uses 1.8% of the case population pharmaceutical expenditures.

Average pharmaceutical expenditures per disposition were $394 with a SE of $1,716. Average pharmaceutical spending was greatest for Oncology at $1,782, versus the lowest average expenditures in Anesthesia & Critical Care and Opthalmology, $31 and $82 respectively. The distribution of pharmaceutical expenditures is very skewed amongst the hospital, with a substantial number of cases having very low dollar expenditures while others had very high expenditures (particularly in Oncology).

The last two columns of Table D2 describe spending for those in the top 10% of the expenditure distribution. Mean case expenditures in this top decile for four of the FU's exceeded those for all their respective FU's by a factor of over 7.6. The expenditures for the remaining six FU's in this top decile exceeded those for all of the individual FU cases by factors ranging from 3.2 to 6.9. The patients in Oncology in the top decile spent an average of $11,538. The rest of the FU's ranged from the lowest average expenditure at $100 in

Anesthesia & Critical Care up to $3,097 for Surgery. The pharmaceutical expenditures for FU's in this top decile accounted for between 38.3% to as high as 81.6% of total dollars expended on drugs in their respective FU.

Expenditures by Medical Diagnosis Group.

Findings from the analysis of pharmaceutical expenditures by MDG were similar to those for the FU. This is to be expected due to the similar relationships between the mission of the FU's and the individual diagnoses recorded under each MDG. For the period under study, over 66% of pharmaceutical expenditures were for drugs utilized in six of the twenty-five MDG's, Myeloproliferative Diseases at 18.5%, Circulatory System at 14.7%, Respiratory System at 9.8%, Nervous System at 8.5%, Hepatobiliary System at 8.0%, and Digestive System at 6.9%. Of these MDG's, Myeloproliferative Diseases' (where the majority of Oncology cases are coded) utilization is highly visible. Although this MDG ranks near the middle in average number of cases represented, it ranks the highest in dollars expended for pharmaceuticals. The relationship of the rankings for the MDG for the Hepatobiliary System & Pancreas are similar to those for Myeloproliferative Diseases. Spending on these two MDG's would be expected to be high as two of the criteria for exemptions to the HSCRC regulations are met, oncology cases and transplant cases.

Average pharmaceutical spending was greatest for Myeloproliferative Diseases at $2,112, versus the lowest average expenditures in Male Reproductive System and Burns, $28 and $57 respectively. As mentioned earlier under the FU pharmaceutical analysis, the distribution of pharmaceutical expenditures is very skewed amongst the hospital, with a substantial number of cases having very low dollar expenditures while others had very high expenditures.

The last two columns of Table D3 describe spending for those in the top 10% of the expenditure distribution. Mean case expenditures in this top decile for eleven of the MDG's exceeded those for all their respective MDG's by a factor of over 7.3. The expenditures for the remaining fourteen MDG's in this top decile exceeded those for all of the individual MDG cases by factors ranging from 5.2 to 7.0. The patients in the Myeloproliferative Diseases in the top decile spent an average of $11,510, compared to $148 for the lowest expenditure in the MDG representing the Male Reproductive System up to $5,411 for the MDG for the Hepatobiliary System & Pancreas. The pharmaceutical expenditures for MDG's in this top decile accounted for between 52.2% to as high as 86.4% of total dollars expended on drugs in their respective MDG.

Tests of Model Specification

Hospital inpatient pharmaceutical cost modeling on LOS and APRSI retained the advantage of statistically controlling for the effects of the independent variable in the multiple regression equation and enabled the avoidance of methodological issues related to reliance on regression coefficients of individual variables in the model (Brooke et al., 1994). Pearson's Correlation Coefficient was found to be statistically significant between costs and LOS and costs and APRSI (R = .425 and R = .238 for LOS and APRSI, respectively, p < .000 for both). The low degree of correlation between cost and APRSI, yet statistical significance, can most probably be explained by the large sample size. Pearson's Correlation Coefficient between LOS and APRSI showed a moderate degree of multicollinearity between these two coefficients (R = .438, p < .000). The approach used in this model was able to avoid the issue of regression coefficient instability due to moderate multicollinearity between these independent variables.

Appendix E presents results of hierarchical multiple regression analyses that evaluated the degree to which the model of hospital inpatient pharmaceutical costs was appropriately specified. As indicated in Appendix E, each of the independent variables accounted for a statistically

significant increase in the explained variance in pharmaceutical costs. The amount of shared variance between LOS and costs and APRSI and costs ($\underline{R}^2$ = .129 and $\underline{R}^2$ = .002 for LOS and APRSI, respectively) illustrates the relative weakness of the model for explaining pharmaceutical costs as a function of LOS and APRSI. The full regression equation yielded both an $\underline{R}^2$ and an adjusted $\underline{R}^2$ of .24 for the model. This was evidence of an appropriately specified model with relatively strong goodness of fit.

These results are evidence that, as a group, the independent variables specified were consistent with previous model building addressed in the literature review, explaining 24% of the variance in pharmaceutical costs in the samples. Additionally, the amount of shared variance accounted for in the full model ($\underline{R}^2$ = .24) means that this model does not account for most of the factors that cause variation in pharmaceutical costs, pointing out that other explanatory variables are in existence that are not explained by this model. This is consistent with the literature review, which highlighted the fact that predicting pharmaceutical costs is a laborious, time consuming yet necessary team effort on the part of administrators, pharmacists, and clinicians, which has many factors contributing to the escalation of costs. This is also consistent with the descriptive statistics, which

highlighted the variation of pharmaceutical costs across FU's and MDG's.

Further Discussion & Recommendations

The purpose of this study was to evaluate the pharmaceutical costs, LOS, and APRSI for the FU's at JHH for the development of a justifiable flexible budget model for the hospital pharmaceutical expense budget. The findings of this research support the stated goal of this project. This was to identify units of analysis for flexing the pharmaceutical expense budget and to develop a flexible budget model that will better flex the pharmaceutical expense portion of the centralized pharmacy budget. Although the regression analysis validates and supports the premise that the contribution of LOS and APRSI in explaining pharmaceutical expenditure costs is statistically significant, the amount of unique variance explained by each was so small that they should not be considered for use in a flexible budget model.

This data indicates how inpatient drug expenditures are distributed amongst both FU's and MDG's. This data on drug expenditures can be used to direct efforts toward improving physician prescribing patterns. The data presented above indicated that drug expenditures were positively correlated both with LOS and APRSI. Such information can be used to target drug utilization review programs.

How pharmaceutical expenditures vary by FU and MDG over time is subject to change as described in the literature review. The data reported above describes the distribution of inpatient drug expenditures over a period of four months. As pointed out in the literature review, factors such as advances in drug technology, as well as prescribing patterns, price changes, alternative use of pharmaceuticals, and other technological developments in healthcare may affect the distribution of pharmaceutical expenditures. Therefore, point estimates by FU or MDG may be different today than a year from now. Nevertheless, these findings suggest the utility of additional study of differences with respect to pharmaceutical expenditures in different FU's and MDG's. Results of these studies might be used in structuring utilization reviews or clinical pathways to help maintain quality of care while controlling expenditures.

A noted weakness with this study was the timeframe that data was available for use in this analysis. Other measures of volume should be considered and a year or more of data could be utilized. Further analysis is required to determine if some other proxy for volume can be appropriately utilized as a basis upon which to flex volume expenditures in the pharmaceutical expense budget. This measure should be captured reliably and easily within an existing database. The

availability of the required information is currently suspect as to whether it is possible within the information systems at JHH to easily obtain these measures as they relate to pharmaceutical costs. With BDM now proliferated across all FU's, this information needs to be linked to a central database so that the Departments of Pharmacy and Finance can begin using this captured information. Further analysis as to what other measures are available within JHH for measuring severity of illness should also be considered.

Conclusions

The findings of this study can aid in establishing units of measurement on which to flex volume and severity of illness for variance analyses of pharmaceutical expenditures by ruling out LOS and APRSI as such measures. By linking the pharmaceutical expenditure data to easily accessible database systems, the Pharmacy should better be able to measure price variances and possible causes of pharmaceutical expenditure variances on a regular basis. This more timely and detailed analysis can aid in the effort to control costs through utilization management and the use of rational drug utilization decisions.

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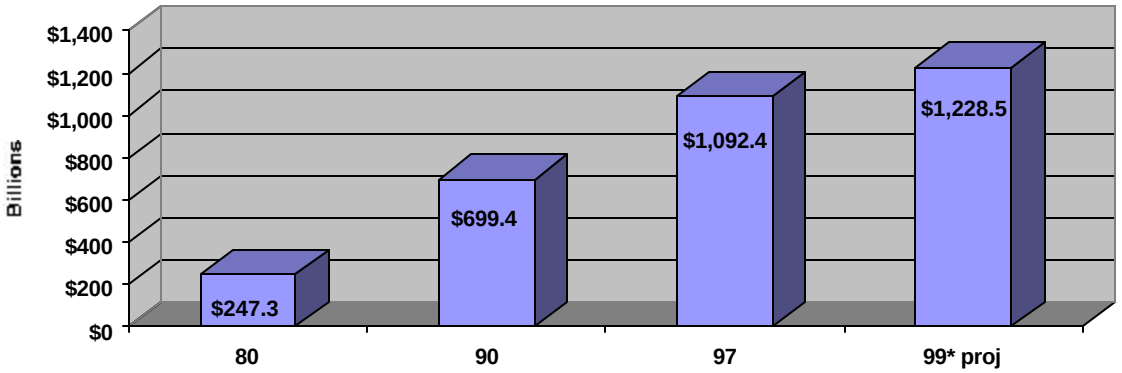
Appendix A

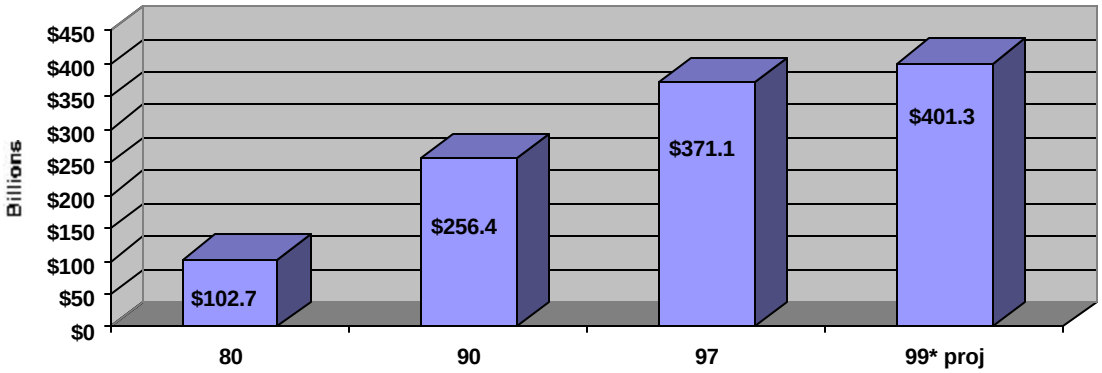
Healthcare Expenditures

Total U.S. Healthcare Expenditures



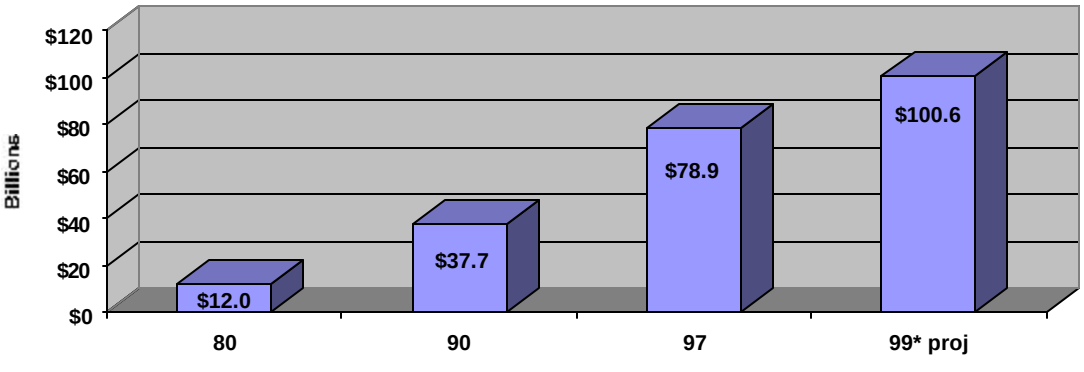
Source: Modern Healthcare, August, 1999

Total U.S. Hospital Expenditures



Source: Modern Healthcare, August, 1999

Total U.S. Prescription Drug Expenditures

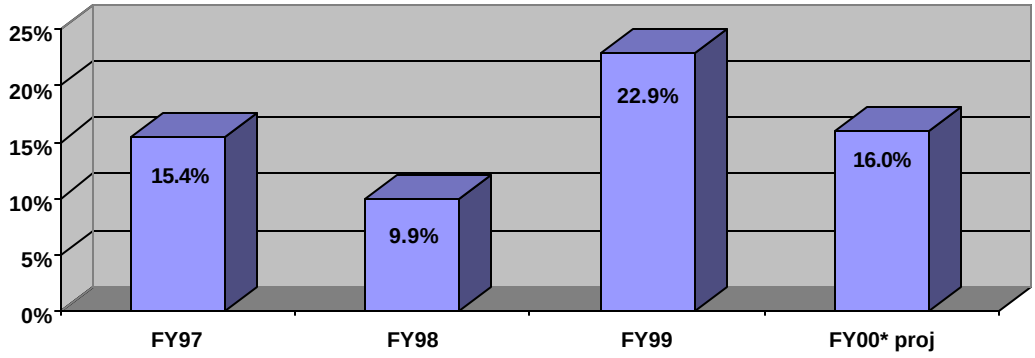


Source: Modern Healthcare, August, 1999

Appendix B

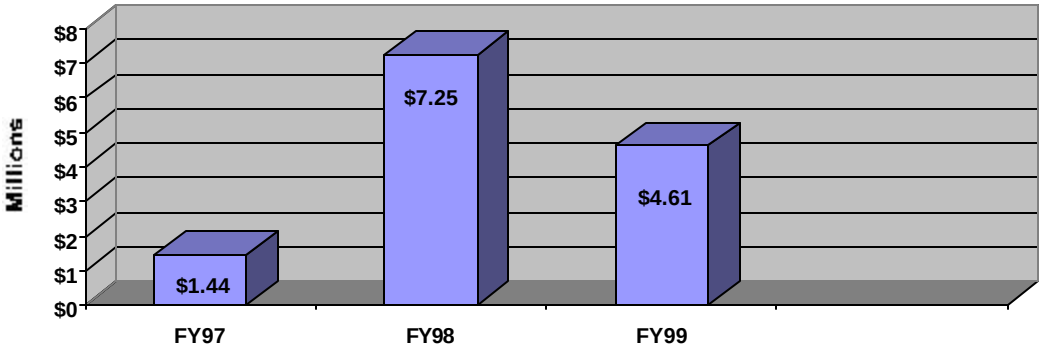
JHH Pharmaceutical Expenditures

JHH Pharmaceutical Expenditures Growth



Source: JHH Pharmacy Budget Report, 1999

JHH Pharmaceutical Expenditures over Budget



Source: JHH Pharmacy Budget Report, 1999

Appendix C

Operationalization of Variables

Variable	Operational Definition
Dependent Variables	
Inpatient Pharmaceutical Costs	Total inpatient drug costs per APR-DRG disposition
Independent Variables	
A. Efficiency	Length of stay measured in inpatient bed days
B. Severity of Illness	All Patient Refined Severity Index weight for each APR-DRG in the dataset
C. Month	Categorical variable set identifying monthly data for June, July, August, and September of 1999 (four Categories, binary-coded 1, 0)
D. Functional Units	Categorical variable set representing functional unit (ten categories, binary-coded 1, 0, to reflect Opthalmology, Psychiatry, Surgery, Pediatrics, Neurology, Gynecology/Obstetrics, Anesthesia & Critical Care, Medicine, Physical Medicine & Rehabilitation, and Oncology)
E. Major Diagnostic Groups	Categorical variable set representing the APR-DRG MDG's (twenty-five categories, binary-coded 1, 0, to reflect Nervous System, Eye, "Ear, Nose, Mouth, & Throat", Respiratory System, Circulatory System, Digestive System, Hepatobiliary System & Pancreas, Musculatory System & Connective Tissue, "Skin, Subcutaneous Tissue, & Breast", "Endocrine, Nutritional, & Metabolic", Kidney & Urinary Tract, Male Reproductive System, Female Reproductive System, "Pregnancy, Childbirth, & Puerperium", Newborns & Other Neonates, "Blood, Blood Forming Organs, & Immulogical", Myeloproliferative Diseases & Poorly Diff Neoplasm, Infectious & Parasitic Diseases, Mental Diseases & Disorders, Substance Abuse & Induced Organic Mental Disorders, "Injuries, Poisonings & Drug Toxicity", Burns, Factors Influencing Health Status, HIV Infections, and Multiple Significant Trauma)

Appendix D

Descriptive Statistics

Table D1

Severity Index (APRSI) & Length of Stay, by Functional Unit

	Distribution of		For those Dispositions in the Upper Decile of Pharmaceutical Expenditures	
Functional Unit	APRSI Mean, $ (SE)	ALOS Mean, $ (SE)	ALOS as % of Total Inpatient Beddays	Mean, $ (SE)
Anesthesia & Critical Care (n=25)	1.8 (0.6)	1.2 (0.6)	12.9	1.3 (0.6)
Physical Medicine & Rehabilitation (n=117)	2.8 (0.7)	9.7 (5.7)	13.5	12.8 (8.5)
Opthalmology (n=136)	1.6 (0.7)	2.0 (2.0)	20.1	3.9 (2.5)
Oncology (n=627)	2.5 (0.9)	7.8 (10.3)	36.1	28.1 (16.4)
Psychiatry (n=695)	2.1 (0.8)	11.8 (12.0)	23.9	28.0 (17.2)
Gynecology/Obstetrics (n=1,150)	1.9 (0.8)	3.4 (3.4)	12.5	4.3 (6.8)
Neurology (n=1,331)	1.9 (0.8)	5.8 (6.7)	30.1	17.3 (13.1)
Pediatrics (n=2,086)	2.0 (0.9)	6.2 (9.8)	24.7	15.4 (16.6)
Surgery (n=3,330)	2.0 (0.9)	6.3 (7.3)	32.0	20.1 (13.4)
Medicine (n=3,368)	2.3 (0.9)	5.3 (7.0)	33.2	17.6 (14.0)
Total Sample (N=12,865)	2.1 (0.9)	6.1 (8.0)	28.4	17.2 (14.8)

Note: Monthly averages based on months June-September of 1999 data.

Appendix D (Continued)

Table D2

Pharmaceutical Expenditures, by Functional Unit

Functional Unit	% of Dispositions from Population	% of Pharmaceutical Expenditures	Distribution of Pharmaceutical Spending		For those Dispositions in the Upper Decile	
			Median, $	Mean, $ (SE)	Pharmaceutical Expenditures as % of Total Pharmaceutical Expenditures	Mean, $ (SE)
Anesthesia & Critical Care (n=25)	0.2	0.0	19	31 (31.6)	38.3	100 (29.7)
Physical Medicine & Rehabilitation (n=117)	0.9	1.0	212	420 (722.5)	49.0	2,007 (1,420.1)
Opthalmology (n=136)	1.1	0.2	20	82 (304.1)	65.5	523 (848.3)
Oncology (n=627)	4.9	22.1	366	1,782 (4,712.0)	65.1	11,538 (10,447.5)
Psychiatry (n=695)	5.4	1.8	52	132 (224.9)	50.2	660 (377.8)
Gynecology/Obstetrics (n=1,150)	8.9	3.8	33	168 (591.2)	76.7	1,285 (1,447.5)
Neurology (n=1,331)	10.3	8.3	44	316 (1,378.1)	81.6	2,579 (3,655.5)
Pediatrics (n=2,086)	16.2	15.5	46	376 (2,070.7)	79.2	2,969 (5,916.2)
Surgery (n=3,330)	25.9	26.7	55	406 (1,459.9)	76.2	3,097 (3,619.6)
Medicine (n=3,368)	26.2	20.7	61	311 (1,023.1)	68.6	2,132 (2,574.0)
Total Sample (N=12,865)	100.0	100.0	53	394 (1,716.2)	77.1	3,035 (4,640.5)

Note: Monthly averages based on months June-September of 1999 data.

Appendix D (Continued)

Table D3

Pharmaceutical Expenditures, by Medical Diagnostic Group

Medical Diagnostic Group	% of Dispositions From Population	% of Pharmaceutical Expenditures	Distribution of Pharmaceutical Spending		For those Dispositions in the Upper Decile	
			Median, $	Mean, $ (SE)	Pharmaceutical Expenditures as % of Total Pharmaceutical Expenditures	Mean, $ (SE)
Burns (n=4)	0.0	0.0	8	57 (87.7)	0.0	0
Multiple Significant Trauma (n=35)	0.3	0.2	48	266 (624.8)	68.5	1,592 (1,296.7)
Substance Use & Induced Organic Mental Disorders (n=67)	0.5	0.1	25	65 (104.3)	54.2	338 (122.2)
Eye (n=695)	1.1	0.2	24	75 (152.7)	56.0	420 (304.7)
Factors Influencing Health Status (n=220)	1.7	1.1	57	245 (567.3)	59.9	1,471 (1,196.8)
Injuries, Poisonings, & Drug Toxicity (n=269)	2.1	0.9	33	169 (472.1)	69.9	1,175 (1,040.9)
Female Reproductive System (n=272)	2.1	1.5	64	277 (1098.0)	78.5	2,188 (2,893.9)
Blood, Blood Forming Organs, & Immulogical (n=287)	2.2	4.1	172	726 (2,399.1)	68.9	4,953 (6,139.1)
Ear, Nose, Mouth, & Throat (n=319)	2.5	0.7	31	117 (495.5)	67.7	791 (1,410.1)
Infectious & Parasitic Diseases (n=324)	2.5	5.1	177	794 (2,490.1)	66.4	5,179 (6,281.8)
Newborns & Other Neonates (n=350)	2.7	0.7	11	101 (366.2)	86.4	874 (831.7)
HIV Infections (n=353)	2.7	3.8	203	542 (1,163.0)	54.8	2,993 (2,539.0)
Male Reproductive System (n=364)	2.8	0.2	16	28 (100.8)	53.2	148 (291.5)
Skin, Subcutaneous Tissue, & Breast (n=402)	3.1	1.7	42	210 (699.3)	73.3	1,550 (1,716.1)
Endocrine, Nutritional, & Metabolic (n=412)	3.2	2.2	38	268 (1,807.7)	81.4	2,140 (5,366.3)
Myeloproliferative Diseases & Poorly Diff Neoplasm (n=443)	3.4	18.5	726	2,112 (4,635.1)	55.4	11,510 (10,198.5)
Kidney & Urinary Tract (n=536)	4.2	4.9	70	462 (1,406.3)	74.1	3,395 (3,151.7)
Hepatobiliary System & Pancreas (n=552)	4.3	8.0	123	737 (3,155.6)	73.1	5,411 (8,738.4)
Pregnancy, Childbirth, & Puerperium (n=686)	5.3	0.9	33	64 (117.4)	53.0	340 (2,04.3)
Mental Diseases & Disorders (n=751)	5.8	1.7	42	117 (211.8)	52.2	609 (377.9)
Respiratory System (n=815)	6.3	9.8	103	611 (2,051.3)	73.2	4,446 (5,023.8)
Digestive System (n=952)	7.4	6.9	68	367 (1,916.7)	73.2	2,691 (5,566.8)
Musculatory System & Connective Tissue (n=1,019)	7.9	3.7	35	183 (863.6)	75.6	1,385 (2,424.3)
Nervous System (n=1,252)	9.7	8.5	42	344 (1,404.7)	80.8	2,782 (3,628.4)
Circulatory System (n=2,041)	15.9	14.7	57	366 (1,304.6)	73.1	2,675 (3,309.9)

N=12865

Note: Monthly averages based on months June-September of 1999 data.

Appendix E

Hypothesis Tests of Effects on Pharmaceutical Costs Uniquely Attributable to Independent Variables

Effect Tested	R^2 Full Model	Adjusted R^2 Full Model	R^2 Reduced	R^2 Uniquely Explained	df1	df2	*F*	*p*
Full Model	.242	.240	0	.240	38	12831	107.747	.000
LOS	.242	.240	.111	.129	37	12832	2183.810	.000
APRSI	.242	.240	.238	.002	37	12832	33.858	.000
Month	.242	.240	.239	.001	35	12834	16.931	.000
Functional Unit	.242	.240	.228	.012	29	12840	203.272	.000
Major Diagnostic Group	.242	.240	.218	.022	14	12855	373.100	.000

N=12865